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SOY BEANS.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., June 30, 1909.

SIR: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin, to supersede Bulletin 58 of the same series, the accompanying manuscript on "Soy Beans," prepared by Prof. Charles V. Piper, Agrostologist in Charge, and Mr. H. T. Nielsen, Scientific Assistant, Forage Crop Investigations.

The soy bean has become a crop of special importance in several Southern States, and interest in it has greatly grown during the past few years. At the present time there is great interest in the crop owing to the possibility that it may be grown on an extensive scale in regions where the boll weevil has rendered the returns from cotton culture uncertain. The recent enormous exportations of soy beans and soy-bean meal from Manchuria to Europe would seem to indicate that there is practically an unlimited market for this product. It is now believed that by the selection of proper varieties, of which the number is very large, the soy bean can be profitably grown in practically all parts of the cotton belt as a grain crop.

It is especially desirable to publish this bulletin at the present time in order that the possibilities of the crop may be generally understood.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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INTRODUCTION.

The soy bean, also called the "soja bean" (fig. 1), is a native of southeastern Asia and has been extensively cultivated in Japan, China, and India since ancient times. Upward of two hundred varieties are grown in these countries, practically every district of which has its own distinct varieties. The beans are there grown almost entirely for human food, being prepared for consumption in many different ways. Their flavor, however, does not commend them to Caucasian appetites and thus far they have found but small favor as human food in either Europe or America.

FIG. 1.—Typical soy-bean plant.

As a forage crop, however, soy beans have become of increasing importance in parts of the United States, especially southward. They have been tested at most of the State agricultural experiment stations, and it is clear that their region of maximum importance will be south of the red-clover area and in sections where alfalfa can not be grown successfully. They thus compete principally with cowpeas, but as cultiva-

tion is usually required they fill a somewhat different agricultural need. Their culture has greatly increased in recent years, especially in Tennessee, North Carolina, Virginia, Maryland, Kentucky, and the southern parts of Illinois and Indiana. It seems certain that the crop will become one of great importance in the regions mentioned and probably over a much wider area. The earlier varieties mature even in Minnesota, Ontario, and Massachusetts.

FIG. 2.—A plant of the Mammoth variety of soy bean, showing its characteristic habit of growth. Height, 40 inches.

As a hay plant the soy bean can not successfully compete with red clover or alfalfa. Unless the yield of grain is 15 bushels or more per acre it is hardly profitable enough to grow it for that purpose alone, as it would be too expensive to feed. Some of the early varieties will yield 16 to 20 bushels or more per acre, and where such yields can be secured the crop is a valuable one.

CLIMATIC AND SOIL REQUIREMENTS OF SOY BEANS.

The soy bean is especially adapted to the cotton belt and northward into the southern part of the corn belt. The early varieties mature in the northern part of the corn belt, but frequently do not make a sufficient yield to warrant growing them. Farther south, where the later and larger varieties can be grown, the yield is sufficient to make their extensive cultivation very profitable. Generally speaking, the soy bean requires about the same temperature as corn. It is perhaps even better adapted to a warm climate and does not do well in a cool climate.

The soil requirements of soy beans are much the same as those of corn. They will make a satisfactory growth on poorer soil than corn, provided inoculation is present, but will not make nearly as good a growth on poor soil as cowpeas. Soy beans make their best development on fairly fertile loams or clays. The Mammoth variety (fig. 2) also succeeds well on sandy soils. On rich soils all

varieties are apt to make a large plant growth and a comparatively small yield of seed, and on the poorer soils a small plant growth with a relatively large seed yield.

Soy beans do not require a well-drained soil for their best development, although they will not grow in a soil where water stands for any considerable length of time. However, they are able to withstand a greater amount of moisture than either corn or cowpeas. In eastern North Carolina on the vegetable mold soils they make excellent crops. On this account soy beans are especially valuable for growing in that region, since the heavy rainfall is the main drawback.

Soy beans are also decidedly drought resistant, much more so than cowpeas, and but for the depredations of rabbits would be a valuable crop in the semiarid West. Rabbits are exceedingly fond of the foliage, and where they are numerous it is nearly useless to plant soy beans unless the field can be inclosed with rabbit-proof fencing.

VARIETIES OF SOY BEANS.

At the present time seven varieties of soy beans, Mammoth, Hollybrook, Guelph, Ito San, Buckshot, Ogemaw, and Wisconsin Black, are handled by American seedsmen. (See fig. 3.) During the past three years more than two hundred additional varieties have been introduced from China, Japan, and India, most of which have already been sufficiently tested to give some idea of their value. Many of the new varieties are so superior in various respects that they are certain to replace all of the above-named varieties except the Mammoth and, perhaps, the Ito San.

The matter of variety is of special importance in soy beans, as many growers have been sorely disappointed in getting a small early variety when they desired a larger and later sort. As this difficulty occurs when there are at most seven varieties handled by seedsmen, it can readily be seen that there is the possibility of greater confusion with the introduction of more varieties. On this account it is very desirable to keep down to the minimum the number of varieties introduced into the seed trade, and these the very best sorts. Seedsmen are urged to use the varietal names here adopted, and buyers should be very careful to specify the variety wanted.

MAMMOTH (YELLOW).

The Mammoth variety (see figs. 2, 3, 4, and 5) is the largest growing and latest of the soy beans at present handled by seedsmen. Under average conditions it will grow from 3 to 5 feet high, depend-

ing principally on the character of the soil. (See fig. 4.) Ordinarily it requires from 120 to 150 days to mature a crop of seed. The Mammoth yields well in both grain and roughage and is satisfactory

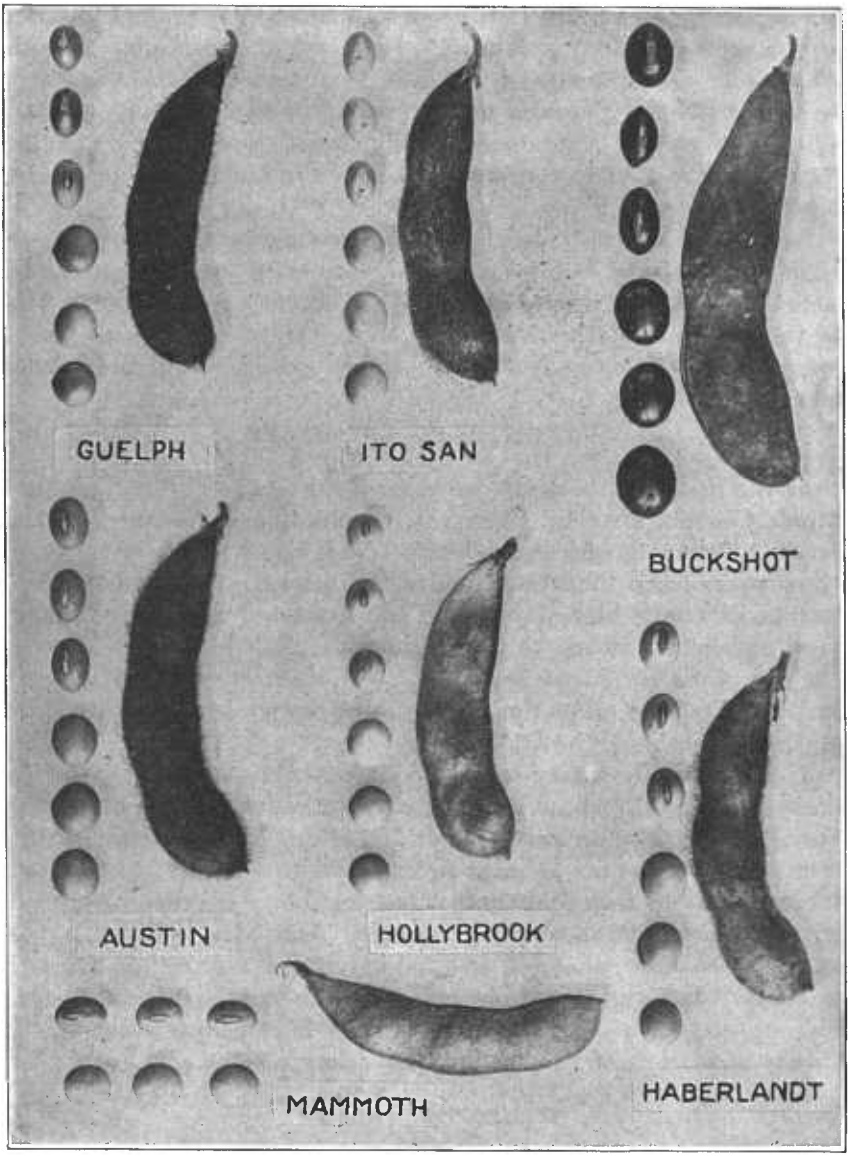

FIG. 3.—Seeds and pods of seven varieties of soy beans. Natural size.

for both. It is a most exacting variety about depth of planting, and under no circumstances should the seed be planted more than 2 inches deep. The habit of growth is such that it can readily be

harvested with machinery and it is frequently gathered with a grain binder. It is well adapted to nearly all of the country south of the northern boundary of Tennessee and can be grown quite successfully some distance north of this, though not as far north as Washington, D. C.

HOLLYBROOK (YELLOW).

The Hollybrook variety is about two weeks earlier than the Mammoth and seldom grows to a greater height than about 3 feet. It is very coarse and woody and therefore not desirable for hay, but it yields large crops of grain. The seed is very nearly identical with that of the Mammoth. The lower branches and pods are apt to be very near the ground, and there is consequently some difficulty in harvesting this variety. It can be grown farther north than the Mammoth, but is not nearly so valuable a variety.

FIG. 4.—A field of the Mammoth variety of soy bean in North Carolina.

ITO SAN (YELLOW).

The Ito San soy bean has been very commonly grown, appearing under the names "Yellow," "Early Yellow," "Medium Yellow," and "Early White," as well as "Ito San." The plants are of medium size, averaging about 30 inches in height, with numerous ascending slender branches, so that this variety can be mown very satisfactorily. It has fine stems and makes excellent hay, though the yield is only moderate. It produces seed fairly well and matures in from 95 to 100 days. It is a very satisfactory variety to grow in a short season or after a small-

grain crop. The seed, which is about the same size as that of the Mammoth, can always be identified by a little brown speck at one end of the hilum, or seed scar. This variety will mature as far north as southern Wisconsin and southern Michigan.

GUELPH (GREEN).

The Guelph soy bean has been advertised more than any other variety, appearing with such names as "Medium Green," "Medium Early Green," and "Large Medium Green." It grows about as large as the Hollybrook variety and matures about 10 days later than the Ito San. The leaves drop without changing color when the plant ripens. The plant is very coarse and not satisfactory for hay. While the seed yield is heavy the pods shatter very much. On these accounts the Guelph is not a desirable variety.

BUCKSHOT (BLACK).

The Buckshot is a very early variety, which has been handled by northern seedsmen. It is also called "Early Black," "Extra Early Black," "Medium Early Black," and "Large Black." It seldom grows more than 24 inches high and is at least a week earlier than the Ito San variety. The seed is considerably larger than ordinary buckshot, but has the same shape. The plants are entirely too small and coarse and produce pods too near the ground to be of much value. If the Buckshot variety is planted at all it should be only in the northern tier of States.

OGEMAW (BROWN).

The Ogemaw is even earlier than the Buckshot variety, and is also a smaller grower and less satisfactory. The seed, which is about the same size as that of the Buckshot variety, can sometimes be purchased from northern seedsmen.

WISCONSIN BLACK.

The Wisconsin Black is an early black-seeded variety that is grown to some extent in Wisconsin and Michigan. Its earliness is its principal merit.

The following new varieties are the best out of more than one hundred sorts tested. They are not yet in the market, but most of them will be available in 1910.

WILSON (BLACK).

The Wilson is a tall variety, growing 3 to 4 feet high, with few erect branches, maturing about one week later than the Ito San. Owing to its tall habit and lack of basal branches it can be harvested easily. It is a heavy grain yielder and also excellent for hay. This variety

should be very valuable in such States as Illinois, Indiana, and Ohio, replacing the Guelph variety especially.

MEYER (MOTTLED BLACK AND BROWN).

The Meyer variety is excellent for hay, as it is tall and has fine stems and branches. During the past three years it has given larger yields of seed than any other variety under trial at the Arlington Experimental Farm in Virginia. Its tall habit makes it easy to mow, but unfortunately it is somewhat inclined to lodge. It matures in 110 days. The seeds are large and break rather easily in thrashing.

AUSTIN (GREENISH YELLOW).

The Austin is a vigorous though not coarse medium-late variety, growing 3 to 4 feet high, with numerous branches but none close to the ground. It can be easily harvested with machinery and is an excellent seed producer.

HABERLANDT (YELLOW).

The Haberlandt variety requires about one week's more time in which to mature than does the Ito San. The seed is considerably larger than that of any of the other yellow-seeded varieties and has a distinctly brown hilum, or seed scar. It is a very heavy yielder of seed, but is rather stocky, seldom growing to a greater height than 30 inches. It can be harvested fairly well with a mower and will give better results than the Ito San variety in many places. Under the conditions in Tennessee it has proved very satisfactory and is strongly recommended there when an earlier variety than the Mammoth is desired.

RICELAND (BLACK).

The Riceland is a soy bean which requires a very long season in which to make its full development, and is therefore adapted only to the cotton belt. The seed is rather small, long, and flat, and covered with a powdery bloom which makes it look dusty. The plants grow from 4 to 6 feet high, but have fine stems and consequently are of a very desirable type for hay.

THE CULTURE AND PLANTING OF SOY BEANS.

Good preparation of the soil is necessary for soy beans; otherwise weeds are likely to choke out the young plants. This preparation should consist of deep plowing and subsequent working with disk and harrow until a firm seed bed, with the upper 2 or 3 inches loose and mellow, is secured. Under nearly all conditions the crop should be grown in rows and given sufficient cultivation to keep down weeds. If the ground is exceptionally free from weeds soy beans

may be sown broadcast or drilled with the idea of using them for hay. The yield of seed is nearly always greater when grown in cultivated rows.

Soy beans if in rows should be planted so as to have a plant on an average of every 2 or 3 inches in the row and the rows from 30 to 36 inches apart. Cultivation can be more easily accomplished if the rows are 36 inches apart than where the distance is less, though the plants have room for development in 28-inch rows. In eastern North Carolina soy beans are planted in rows 4 feet apart and hilled as high as possible to aid in drainage, which is very important in that region.

It is especially important to plant seed of good quality. Soybean seed unless it is fresh and has been properly stored is very apt to be low in germination. It should therefore be tested for viability before planting time. The planting should be shallow, preferably 1 inch and not to exceed 2 inches in depth. Poor stands result more frequently from too deep planting than from any other cause. A bushel of good seed is sufficient to plant from 2 to 3 acres if in cultivated rows, and hardly enough for 1 acre if sown broadcast.

The cultivation of soy beans is a simple matter. Unless conditions are very unfavorable the seedling plants appear above ground in a week and tillage may then begin. Any good cultivator may be used, and flat cultivation is preferable, as the harvesting can be more easily done than if the rows are hilled or ridged.

Soy beans may be planted through a wide period from early spring till midsummer. Ordinarily they are planted about June 1. In the lowlands of Tennessee and North Carolina and southward two crops of the early and medium varieties may be secured in a season. In general, early plantings require more time to mature than late plantings, the difference in the same variety often amounting to as much as three weeks.

THE INOCULATION OF SOY BEANS.

Like other legumes, soy beans are able to utilize the nitrogen of the air and add it to the soil by means of root nodules. These nodules (fig. 5) are caused by certain bacteria; unless they are present soy beans in the usual types of soil will make but a weak growth, and many of the plants will turn yellow and die.

Throughout the South the proper bacteria for soy beans seem to be widely distributed, so that natural inoculation now occurs generally. In isolated localities where this crop has not been grown, however, some difficulty may be expected from lack of inoculation during the first season at least. Northward and westward greater difficulty in this regard is experienced.

Inoculation of a new field may be secured either by the soil-transfer method or by the use of the pure cultures prepared by the Department of Agriculture. The soil-transfer method consists in scattering soil from an old, well-inoculated soy-bean field over the new ground at the rate of 200 to 300 pounds per acre. To facilitate even scatter-

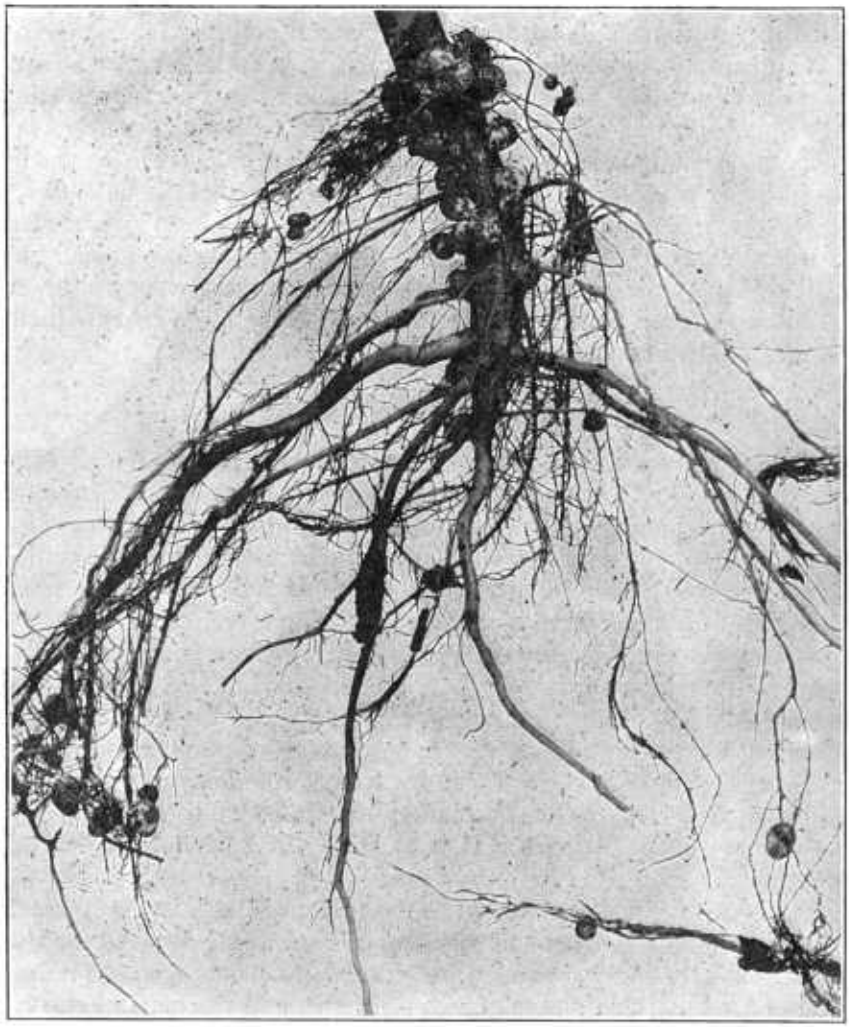

FIG. 5.—Roots of a plant of the Mammoth variety of soy bean, showing characteristic nodules.

ing this should be thoroughly mixed with several times its weight of ordinary soil. The soil may be either drilled or broadcasted. In the latter case it should be done toward evening or on a cloudy day, as bright sunshine is very harmful to the germs. The objections to the soil-transfer method are the labor and cost involved and the serious

liability of spreading weeds and dangerous plant diseases. Successful inoculation by this method is, however, practically certain.

The method of inoculation by means of the pure cultures prepared by the United States Department of Agriculture is fully described in Farmers' Bulletin 315. Fresh liquid cultures are sent out in sealed bottles, and for small quantities of seed the culture may be diluted and used directly upon the seed. Directions and material for increasing the culture are supplied if a larger quantity is desired. The advantages of the artificial cultures lie in the greater ease of transportation and application, as well as in the absence of the danger of introducing plant diseases or harmful weeds. This method is frequently unsuccessful with soy beans, due possibly to the oily nature of the seeds.

When growing soy bears or any of the legumes for the first time it is an excellent plan to plant a small experimental plat, inoculating thoroughly by the pure-culture method. If this plat is successful, an abundance of soil will be available for inoculating large fields without danger of introducing weeds or diseases.

SOY BEANS FOR HAY.

Soy-bean hay when cut at the proper stage of growth and carefully cured is excellent, and for dairy cattle at least yields results equal to alfalfa hay. For hay production soy beans may be planted in cultivated rows, or when the ground is free from weeds they may be drilled or broadcasted. The late or medium-late varieties are as a general thing best adapted for hay production. These varieties grow to a greater height and have finer stems and branches and more leaves than do the earlier sorts. Of the varieties now handled by seedsmen the best for hay production are the Mammoth and the Ito San. The Mammoth variety makes a very large growth of plant, usually produces a large quantity of seed, and is well adapted for growing in the entire South. The Ito San is smaller, with finer stems, and also yields satisfactory crops of grain. It is at least a month earlier than the Mammoth.

Soy beans are not as a rule to be recommended as a hay crop north of the Ohio River, except in southern Illinois. The reasons for this are the shorter growing season, which tends to encourage the production of seed at the expense of plant growth, and the general culture of red clover, with which soy beans can scarcely compete in the production of hay. To get the best hay from soy beans they should be cut when half or more of the pods are fully grown, but before they begin to change color in ripening. Another rule, which is probably the better one to follow, is to cut when the top leaves begin to turn yellow. This is the best guide in most cases, but does not always apply, as some varieties, notably the Guelph, shed their leaves with-

out change of color. At this stage of growth the largest yield and at the same time a good quality of hay will be secured. If the cutting is done earlier than this, the percentage of protein will be higher and there will be practically no waste in feeding; but the total yield will not be so large and the difficulty of curing much greater. If the cutting is much later than this, the total food constituents will be greater, but there will also be considerable waste of material in feeding due to the stems becoming hard and woody.

CURING THE HAY.

The planting should be timed, so that the crop can be cut for hay in September, as this month is usually the most satisfactory for haymaking. The cutting may begin as soon as the dew is off the plants and continue for the rest of the day. The plants should be allowed to lie in the swath until the leaves are well wilted, but great care should be exercised to rake them before the leaves become dry and brittle. After raking into windrows they should be left for a day or two, depending on the weather, and then put in small cocks or bunches. Three to five or six days of good weather is ample time for making good soy-bean hay. Great care should be used to prevent the loss of leaves, since these are the most valuable part of the plant except the pods.

When the hay is dry, it should be put in good-sized stacks or under a shed. If it is stacked in the open field it is very essential that some other material, either grass or a canvas cover, be put over the stack, as soy-bean hay does not shed rain well. Yields of from 1 to 3 and occasionally 4 tons of cured hay to the acre are secured. The average yield is about 2 tons per acre.

Curing frames can often be used to good advantage in making soy-bean hay, especially in unfavorable weather. The object of these frames is to keep the cocks open, so as to prevent matting and to allow the circulation of air. They are usually three or four sided pyramids made of boards or poles 3 to 6 feet long, fastened together at the top and held by crosspieces near the base. By this device a hollow cock or shock is secured, and consequent better curing.

In stacking the hay, poles or logs placed in the center of stack, so as to leave passages for air, will greatly lessen the danger of spoiling.

SOY BEANS FOR PASTURAGE.

The soy-bean crop can often be profitably utilized by pasturing, particularly to hogs, especially when fed corn in addition. This is advisable when harvesting is interfered with by lack of labor, bad weather, or other causes and when the crop is grown especially for soil improvement. By this means not only is the crop profitable in

itself, but the manure is returned to the soil. The usual practice is to turn the hogs into the soy beans when the pods are nearly full of grain, but before they have begun to ripen. In pasturage experiments conducted at the Alabama Agricultural Experiment Station,[a] the following crops as pasturage for hogs were compared: Soy beans, peanuts, chufas, and sorghum. In these experiments it was found that when corn alone was fed 100 pounds of pork cost $7.63; when fed a two-thirds ration of corn and pastured in addition 100 pounds of pork cost $8.89 when on chufa pasture, $7.79 on sorghum pasture, $3.20 on peanut pasture, and $2.74 on soy-bean pasture. The average gain of the pigs each day on the soy-bean pasture was 1.02 pounds, on the peanut pasture 1.01 pounds, on the chufa pasture 0.72 pound, and on the sorghum pasture 0.37 pound. In this experiment the hogs were turned into the soy beans while the pods were very small, so that for two weeks they ate only the leaves and young shoots.

In a similar experiment conducted at the Arkansas Agricultural Experiment Station the effect of the legume crop grazed by hogs was determined on the two succeeding cotton crops as compared with cotton following corn not grazed. The figures show that the two cotton crops aggregated 2,905 pounds of seed cotton following peanuts grazed, 2,608 pounds following soy beans grazed, and only 1,802 pounds following corn not grazed.

SOY BEANS IN MIXTURES.

There has been but little experimenting as yet in growing soy beans in mixtures with other plants. What little has been done indicates that the soy bean may be satisfactorily grown in combination with a number of other agricultural crops.

SOY BEANS AND COWPEAS.

Soy beans and cowpeas make a very satisfactory mixture for hay purposes. The tall, strong-growing varieties of soy beans are to be preferred for this combination, as the cowpeas are vining plants and need something to hold them up so that they can be readily harvested. The hay of such a mixture is more desirable than the hay of either crop alone, as it affords variety. The yield also is nearly always greater. There is no doubt that most live stock prefer the soy beans to the cowpeas in this mixed hay, but both plants are eagerly eaten by practically all kinds of farm stock.

In sowing soy beans and cowpeas in mixture about 1 bushel of the former to a half bushel of the latter per acre should be used. If planted in rows, about one-half of this quantity of each is suffi-

[a] Bulletin 143, Alabama Agricultural Experiment Station, 1908.

cient. It is necessary to have more soy-bean plants than cowpeas, so that the vining growth of the cowpeas may be supported properly. The Mammoth and Hollybrook varieties of soy beans are preferable. The Whippoorwill and Iron varieties of cowpeas are good.

There has been considerable difficulty experienced in getting a stand of the soy beans when grown in mixture with cowpeas. This is mainly due to putting the seed in the ground too deeply, a point which should be kept constantly in mind in planting soy beans. The planting can be done best with an ordinary grain drill, whether it is to be in cultivated rows or sowed.

The curing of a mixture of cowpea and soy-bean hay is more easily accomplished than the curing of cowpeas alone, and slightly more difficult than in the case of soy beans alone. The time to cut will necessarily depend on the relative stage of growth of the two crops. As nearly as possible, both plants should be at the best stage of growth for haymaking when the harvesting is done. This time is when about half of the soy-bean pods are fully grown and just beginning to ripen and the first pods of the cowpeas are ripe. At this stage of growth they will make a hay the quality of which is hardly surpassed by any other produced on the farm.

SOY BEANS AND SORGO.

The soy bean may be grown in mixture with sorgo (sweet sorghum). There is some objection to the mixture when broadcasted, as the sorgo is apt to choke out the soy beans. When grown together in cultivated rows, this objection is largely overcome. Amber sorgo is usually the best variety for use.

SOY BEANS AND MILLET.

Some of the earlier varieties of soy beans have been grown with German millet. The mixture is not a good one, as the millet matures long before the soy beans.

SOY BEANS AND CORN.

Soy beans are more commonly grown with corn than with any other crop. They are planted in different sections in various ways, namely, in alternate hills with the corn in the same row, in alternate rows of each, in alternate series of two rows of each, or broadcasted in mixture. Such fields when planted in rows may be harvested for silage, or where the rows alternate the two crops may be harvested separately. Sometimes such mixed fields are utilized by pasturing to hogs. The early and medium varieties of soy beans may be planted in between the corn rows at the time of the last cultivation.

SOY BEANS FOR ENSILAGE.

The growing of soy beans for ensilage has not been practiced very extensively. In a number of instances ensilage has been made of the crop, usually in combination with corn, and it is invariably reported as making an excellent succulent feed. Only the larger late-growing varieties are desirable for this purpose. Some have tried growing soy beans in the corn rows or between the corn rows, planting them the same as cowpeas are planted in the cornfields of the South, while others prefer growing corn and soy beans in separate fields and when the ensilage is put up to mix them in the cutting. Where the soil and climate will permit, it would seem to be more satisfactory to grow the soy beans in the cornfield. It is doubtful whether it will be economical to make ensilage of soy beans when hay can be made with comparative ease. Corn deteriorates so much more rapidly in the shock than do most of the crops which can be made into hay that if ensilage is to be made on the farm the more economical practice will likely be to use the corn crop for this purpose and save the other crops for hay.

SOY BEANS FOR GRAIN.

Growing soy beans for the grain for use as feed is distinctly profitable if the yield is 16 bushels or more per acre. The feeding value of the grain is very high, being slightly superior to cotton-seed meal. The grain is rich in protein, while nearly all the other grains produced on the farm are poor in protein, but rich in carbohydrates.

For grain production tall varieties that do not branch or bear pods close to the ground are desirable, as they are more easily harvested. Of the varieties now on the market the Mammoth and Hollybrook are undoubtedly much the best for the South, while the Ito San and the Guelph, which is also known to the trade as Medium Green, are best for more northerly latitudes. A very serious objection to the Guelph, however, is its great tendency to shatter seeds at ripening time.

When grown for grain alone, the cutting may be delayed in the case of most of the varieties until all of the leaves have fallen. The Guelph and a few other varieties not on the market retain the leaves late and much seed would be lost by shattering if the harvesting were not done earlier. The plants should be allowed to become thoroughly dry after cutting before they are stacked or put into a barn or shed. Care should be taken, however, not to let them get too dry before they are piled into bunches, as there is likely to be considerable shattering of seed in such cases, especially if rained upon.

Thrashing is most satisfactorily done in the field without previous stacking, if conditions will permit. It is hardly possible under most conditions to harvest the crop without getting a certain quantity of soil mixed with it, and if the thrashing is done outside the resulting dust is not nearly as troublesome as when done inside. The fine hairs on the stems and pods also make a disagreeable dust in thrashing.

Harvesting may also be done when the leaves first begin to fall, getting in this way practically as much seed as when the plants are allowed to mature, and besides saving all the leaves. Such straw is much more valuable as feed than the stems alone, though stock will eat both readily. This last method is undoubtedly the most profitable way of handling the soy-bean crop if it is grown as forage for farm live stock. One field in eastern Tennessee produced in this way 25.5 bushels of grain and nearly 2 tons of straw to the acre. The Mammoth variety in a number of tests at the Tennessee Agricultural Experiment Station averaged nearly 20 bushels per acre and 1½ tons of straw when grown in acre plats.[a]

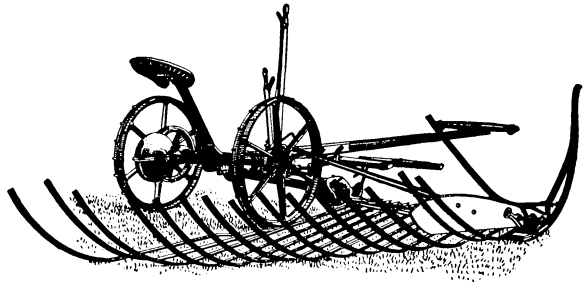

FIG. 6.—A bunching attachment on an ordinary mower.

One of the principal drawbacks in growing soy beans for seed has been the harvesting. The small early varieties can be harvested only with a mowing machine or a bean harvester, or by hand. The bean harvester has not given very satisfactory results. The mowing machine is apt to cut many of the lower pods in two and even leave some of them on the stubble. Hand work is too laborious and expensive. Many of the later and more erect-growing varieties can be satisfactorily harvested with a mowing machine or a drop-rake reaper, and the taller varieties even with a self-binder. The self-binder is the most satisfactory machine to use with tall varieties. With lower varieties the drop-rake reaper is recommended. This machine will leave the crop in small bunches which can easily be gathered. As the drop-rake reaper will cut as low as a mowing machine it is preferable to a mower. It can also be used very satisfactorily for harvesting cowpeas. On a small farm the drop-rake reaper is perhaps too expensive to justify purchasing, but here the mower with a side-delivery attachment can be made to answer the purpose. (Fig. 6.)

[a] See Bulletins 78 and 80, Tennessee Agricultural Experiment Station.

SOY BEANS IN ROTATIONS.

Soy beans are admirably adapted to short rotations, taking either an entire season or a part of a season following some small-grain crop. In Tennessee and North Carolina a soy-bean crop is often grown between two wheat crops, and in other parts of the South between oat crops. In such cases, however, an early variety like the Ito San or the Haberlandt is preferable.

Where a whole season is devoted to soy beans two crops of the earlier varieties can be matured in all parts of the cotton belt, and this is in many cases preferable to growing a single crop of a late variety. Where the whole season is thus devoted to soy beans, they may take any place in a rotation system where corn can be used.

The consensus of opinion among farmers is that a crop of soy beans benefits the succeeding crop, but not to so great a degree as one of cowpeas. More accurate data on this point are needed.

Regarding the fertilizer requirements of soy beans there are but few data available. Where fertilizers are used, the general practice is to use acid phosphate at the rate of 200 to 300 pounds per acre and muriate of potash at the rate of 50 pounds per acre.

FEEDING VALUE OF SOY BEANS.

The feeding value of any forage crop and for any particular purpose can be determined only by actual feeding experiments. There are, of course, definite relations between the digestible constituents of a feed and the resultant gains in flesh or milk. These relations are, however, more complex than a table of analyses indicates. On this account the relative value of feeds is best shown by comparative feeding trials. Such trials indicate that good soy-bean hay is about equal to alfalfa for milk and butter production. They also show that soy-bean meal is somewhat superior to cotton-seed meal in the production of pork, mutton, and milk. Soy-bean meal also proves to be slightly more valuable than wheat middlings in feeding hogs.

FEEDING VALUE FOR SHEEP.

The Wisconsin Agricultural Experiment Station[a] has tested the value of soy-bean seed for fattening lambs. In one experiment two lots of 10 lambs each were fed the same roughage. One lot received shelled corn and whole soy beans in equal proportions, while the other received the same quantities of shelled corn and whole oats. The average gain of each lamb during a period of twelve weeks was 16.3 pounds when soy beans constituted a part of the ration and but 13.7 pounds when oats were used. A pound of gain was produced on 6.11 pounds of grain and 7.11 pounds of roughage in the soy-bean ration,

[a] Annual Reports, Wisconsin Agricultural Experiment Station, 1904 and 1905.

while 7.28 pounds of grain and 8.62 pounds of roughage were required on the oats ration.

In another experiment the same rations were fed for twelve weeks to two lots of 9 lambs each. The lot receiving the soy-bean ration gained 119 pounds in weight and produced 95.1 pounds of wool, against 71 pounds increase in weight and a production of 81.3 pounds of wool for the lot receiving the oat ration. The second lot also consumed more feed per pound of gain.

FEEDING VALUE FOR DAIRY COWS.

Soy-bean meal has been found a most excellent feed for dairy cows. The Massachusetts Agricultural Experiment Station[a] compared soy-bean meal and cotton-seed meal, using the same ration otherwise. The quantity of milk produced from the soy-bean ration was slightly larger. The butter from the cows fed cotton-seed meal was of firmer texture, but not nearly as good otherwise as the butter from the cows fed soy-bean meal. The test indicated that soy-bean meal was superior to cotton-seed meal for both milk and butter production.

At the Tennessee Agricultural Experiment Station[b] three groups of cows of two lots each were fed to compare (1) soy-bean straw and corn stover; (2) soy-bean hay and alfalfa hay, and (3) soy-bean meal and cotton-seed meal. There was no chance in these experiments for the individuality of the animals to affect the results, as each lot was fed on the separate rations at different periods in the course of the experiments.

Soy-bean straw was found very palatable and superior to corn stover as a feed. More feed was eaten in the case of the soy-bean straw, but the cost of the feeds consumed during a thirty-day period was practically the same. The soy-bean ration produced 12 per cent more milk and 14 per cent more butter fat, so that the cost of a gallon of milk was 1.2 cents less and of a pound of butter fat 2.1 cents less than when corn stover was fed as roughage.

In the comparison of soy-bean hay and alfalfa hay, these substances were fed in combination with corn silage and corn-and-cob meal. Each lot of cows consisted of four Jerseys, and the test lasted through three periods of thirty days each. At the end of this time the results were in favor of the soy-bean hay by 245 pounds of milk and 20.5 pounds of butter fat. This result indicates a slight superiority of soy-bean hay over alfalfa hay.

In the trial for the comparison of soy-bean meal and cotton-seed meal the yield both of milk and of butter fat was about 5 per cent greater for the soy-bean meal.

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[a] Annual Report, Massachusetts Agricultural Experiment Station, 1893, pp. 13–14.

[b] Bulletin 80, Tennessee Agricultural Experiment Station, 1908.

FEEDING VALUE FOR HOGS.

The Wisconsin Agricultural Experiment Station [a] compared soy-bean meal and wheat middlings for pork production in three separate experiments in as many years. Two-thirds of the grain ration was corn meal in each case. In each of the experiments the largest gains were made on the soy-bean rations. Soy beans proved about 10 per cent superior to wheat middlings for pork production, figuring the cost of the feeds as the same.

The Indiana Agricultural Experiment Station [b] compared rations of 2 parts of corn meal and 1 part of soy-bean meal with corn meal and wheat middlings in equal proportions and with 5 parts of corn meal and 1 part of tankage for pork production. The soy-bean ration produced the largest daily gains, and this with the smallest quantity of feed consumed for each pound of gain.

The Kansas Agricultural Experiment Station [c] has several times tested the value of soy-bean meal in combination with corn meal and with kafir meal in comparison with the two latter feeds alone in feeding hogs. The feeds were mixed in the proportion of four-fifths corn or kafir and one-fifth soy beans. Larger gains, varying from 13 to 37 per cent, were made in every case on the mixed rations than on corn or kafir alone.

With corn meal alone 100 pounds of gain cost $3.92, with corn meal and soy-bean meal $3.73, and with kafir meal and soy-bean meal $3.37. For these computations the value of corn meal was fixed at $14 a ton, kafir meal at $13 a ton, and soy beans at $25 a ton, or 75 cents a bushel.

STORING SOY-BEAN SEED.

The storage of soy-bean seed requires special care. The grain should be thoroughly dry when put into storage or else placed where good ventilation is afforded; otherwise it is almost certain to heat and be ruined as far as germination is concerned. No matter what may be the condition of the seed at the time it is stored, it should be examined occasionally to detect any tendency to heat.

Even when soy-bean seed has been stored carefully the germination is apt to fall off rapidly. In fact, it is as a rule unwise to plant seed more than one season old without first testing it for germination. Unlike cowpea seed that of soy beans is rarely attacked by weevils.

[a] Annual Reports, Wisconsin Agricultural Experiment Station for 1904, 1905, and 1906.

[b] Bulletin 108, Indiana Agricultural Experiment Station, 1905.

[c] Bulletin 92, Kansas Agricultural Experiment Station, pp. 24–25, and Press Bulletin No. 141, 1905.

COMPARISON OF SOY-BEAN GRAIN AND COTTON-SEED MEAL.

Throughout much of the region well adapted to soy beans dairy farmers purchase cotton-seed meal for a high-protein feed. Numerous experiments have shown that soy-bean meal is equal or slightly superior as a feed to cotton-seed meal both for cows and for hogs.

Yields of 20 bushels per acre of soy beans on lands of moderate fertility may confidently be expected in the region where the best medium or late varieties will mature. On the comparatively poor soils of the Arlington Experimental Farm in Virginia yields of the best varieties have been obtained in acre plats as follows: Acme, 29.7 bushels; Meyer, 23.6 bushels; Tashing, 23.3 bushels; Wilson, 23.1 bushels; Jet, 22.6 bushels; Ito San, 22.6 bushels; Guelph, 21.6 bushels; Flat King, 21 bushels. Similar, and in many cases larger, yields are reported by many farmers and by the agricultural experiment stations of Tennessee, Virginia, Delaware, New Jersey, Indiana, Wisconsin, Rhode Island, and Massachusetts. Yields of 40 to 50 bushels per acre have frequently been reported, and some writers have mentioned yields of 100 bushels per acre. It is doubtful whether yields of even 50 bushels per acre are made, except on small areas.

The above seed yields are comparable in value to those of wheat or corn, and the crop may come to be grown extensively as a money crop, especially in regions where the boll weevil makes cotton culture uncertain. For the present, however, the culture of soy beans is recommended mainly to those farmers who can feed the crop.

During the past ten years soy-bean meal has been imported into Europe in large quantities from Manchuria, and has met ready sale at a price above that of cotton-seed meal. This would seem to assure a market for practically unlimited quantities. Whether soy-bean oil would find an economic use comparable to that of cotton-seed oil remains to be determined, as does also the feeding value of soy-bean meal from which the oil has been extracted.

The relative richness of the soy bean in oil and other constituents as compared with other oily seeds is shown in the following tables:

TABLE I.—*Analyses of seeds of seven varieties of soy beans.*[a]

Variety.	Fresh or air-dry substance.					
	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Austin	8.67	36.59	20.55	24.41	4.00	5.78
Ito San	7.42	34.66	19.19	27.61	5.15	5.97
Kingston	7.45	36.24	18.96	26.28	4.79	6.28
Mammoth	7.49	32.99	21.03	29.36	4.12	5.01
Guelph	7.43	33.96	22.72	25.47	4.57	5.85
Medium Yellow	8.00	35.54	19.78	26.30	4.53	5.85
Samarow	7.43	37.82	20.23	23.65	5.05	5.82
Average	7.70	35.40	20.35	26.15	4.60	5.79

[a] Bulletin 82, Tennessee Agricultural Experiment Station, p. 97. 1908.

TABLE II.—*Analyses of cotton seed, sunflower seed, and peanuts.*

Kind of seed.	Fresh or air-dry substance.					
	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
Cotton seed (whole):	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Minimum	8.00	13.62	10.40	7.58	17.60	2.89
Maximum	17.51	29.70	29.34	36.70	32.40	8.00
Average of 25 analyses	9.92	19.38	19.45	22.57	22.57	4.74
Sunflower seed (whole):						
Minimum	8.50	15.80	20.90	22.00	29.50	2.10
Maximum	8.80	16.70	21.50	20.70	30.30	3.20
Average of 8 analyses	8.60	16.30	21.20	21.40	29.90	2.60
Peanuts (kernels):						
Minimum	4.90	23.20	35.00	12.70	2.00	1.90
Maximum	13.20	31.50	47.40	19.10	18.40	3.80
Average of 7 analyses	7.50	27.90	39.60	15.60	7.00	2.40

COMPARISON OF SOY BEANS AND COWPEAS.

Inasmuch as the soy bean is adapted to nearly the same place in the farm rotation as the cowpea, a comparison of the two plants is pertinent.

The soy bean is determinate in growth; that is, it reaches a definite size and matures. Nearly all varieties of cowpeas, on the other hand, are indeterminate, continuing growth until killed by frost.

Soy beans, with the exception of a few varieties, do not vine, but grow erect or nearly erect. Cowpeas, on the other hand, are viny plants, and therefore more difficult to harvest.

Soy beans mature all their pods at one time. Cowpeas continue to produce green pods as long as the plant lives.

Soy beans will withstand quite heavy frosts, both in the spring, when young, and in the fall, when nearly mature, while the same frosts are fatal to cowpeas.

Soy beans are more drought resistant than cowpeas, and in a dry season will give much greater yields; they will also withstand excessive moisture much better.

For green manuring or soil improving, the cowpea is far more valuable than the soy bean, as it will smother weeds much more successfully.

The value of the hay of the two plants is nearly the same. There is frequently doubt as to which is the more desirable to grow. On relatively poor soil or when broadcasted cowpeas are always preferable. When cultivated, the soy bean will yield the greater return, and if cut late the hay is more easily cured.

For growing with corn or sorghum for hay or silage the cowpea is generally preferable to the soy bean.

The feeding value of an acre of soy beans for beef cattle was found by the Tennessee Agricultural Experiment Station to be about 50 per

cent greater than that of cowpeas grown on an adjoining acre. This was also approximately the difference in yield of the two crops.

As a grain producer the soy bean is in every way preferable to the cowpea, as it produces larger yields of richer grain and can be harvested much more easily.

The soy bean, therefore, is to be recommended above the cowpea where intensive rather than extensive farming is practicable and desirable.

SUMMARY.

(1) For intensive farming the soy bean is the best annual legume to grow for forage in the southern part of the cotton belt and into the southern part of the corn belt.

(2) The soy bean, whether used as hay, grain, straw, or ensilage, is very valuable as feed for live stock.

(3) Soy-bean hay is practically identical in feeding value with alfalfa and yields from 2 to 3 tons per acre. To make good soy-bean hay the crop must be cut when about half the pods are full grown or when the top leaves first begin to turn yellow.

(4) Soy-bean grain is more valuable than cotton-seed meal as a supplemental feed in the production of pork, mutton, wool, beef, milk, and butter. A bushel of soy beans is at least twice as valuable for feed as a bushel of corn. As the grain is hard it is usually desirable to grind it into meal for feeding. This is best done by mixing with corn before the grinding to prevent gumming up the mill.

(5) Harvesting ordinarily should be done when the leaves first begin to turn yellow, as the quality of the straw rapidly deteriorates thereafter and the yield of seed will be practically as large as at any later time. From 20 to 30 bushels of grain and 1½ to 2 tons of straw per acre are not uncommon.

(6) If soy beans are grown for the seed alone, and sometimes this is desirable, the harvesting can be done most easily by waiting until all the leaves have fallen.

(7) Soy-bean straw, if the crop is cut before the leaves fall, is fully as valuable for feeding as timothy hay for cattle, and is eaten by stock with much relish. Even when the harvesting is delayed until all the leaves have fallen, stock will eat the straw readily.

(8) Mixed with corn, soy beans are excellent for ensilage. The two crops may be grown together, but it is usually better practice to plant in separate fields and mix when putting into the silo.

(9) It is necessary to give the soil thorough preparation in order to be successful with soy beans. Only fresh seed or seed which has been tested for germination should be planted. Two-year-old seed is usually not reliable. The seed should be planted shallow, not to

exceed 2 inches in depth, and preferably in rows 30 or, better, 36 inches apart to permit sufficient cultivation to keep down weeds.

(10) For harvesting soy beans a mower with or without a side-delivery attachment, a self-rake reaper, or a self-binder can be used. A binder can be used only with the tall varieties. The thrashing can be done with a grain separator by using blank concaves and running the cylinder much slower than for small grains or by the use of machines specially designed for handling soy beans and cowpeas.

(11) Soy beans and cowpeas can be grown together satisfactorily; the hay of such a mixture is better than either crop alone and the yield is generally greater. In planting the two together the seed should not be covered too deeply, as deep planting will result in a poor stand of soy beans.

(12) As a crop in a short rotation soy beans are very desirable. They can be grown so as to use an entire season in the case of the late varieties, or two crops in one season can be secured from some of the earlier ones. They can also be used very advantageously to follow a small-grain crop the same season.

(13) The important commercial varieties of soy beans are the Mammoth, the Hollybrook, and the Ito San. Among the most valuable new varieties are the Austin, the Wilson, the Riceland, the Meyer, and the Haberlandt, most of which will be in the hands of seedsmen in 1910.

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